

ALTER



ACCEDE | ESCCON

2025

Seville - Spain
25 to 27th March



TELEDYNE e2v
Semiconductors



Space Qualification of LX2160-Space

Teledyne e2v's Highly Reliable 16 ARM(R) Cortex(R) A72 Processor for Space Applications

Thomas GUILLEMAIN, Vincent THIBAUT – Teledyne e2v

Nourdine KERBOUB, David DANGLA - CNES



Introduction

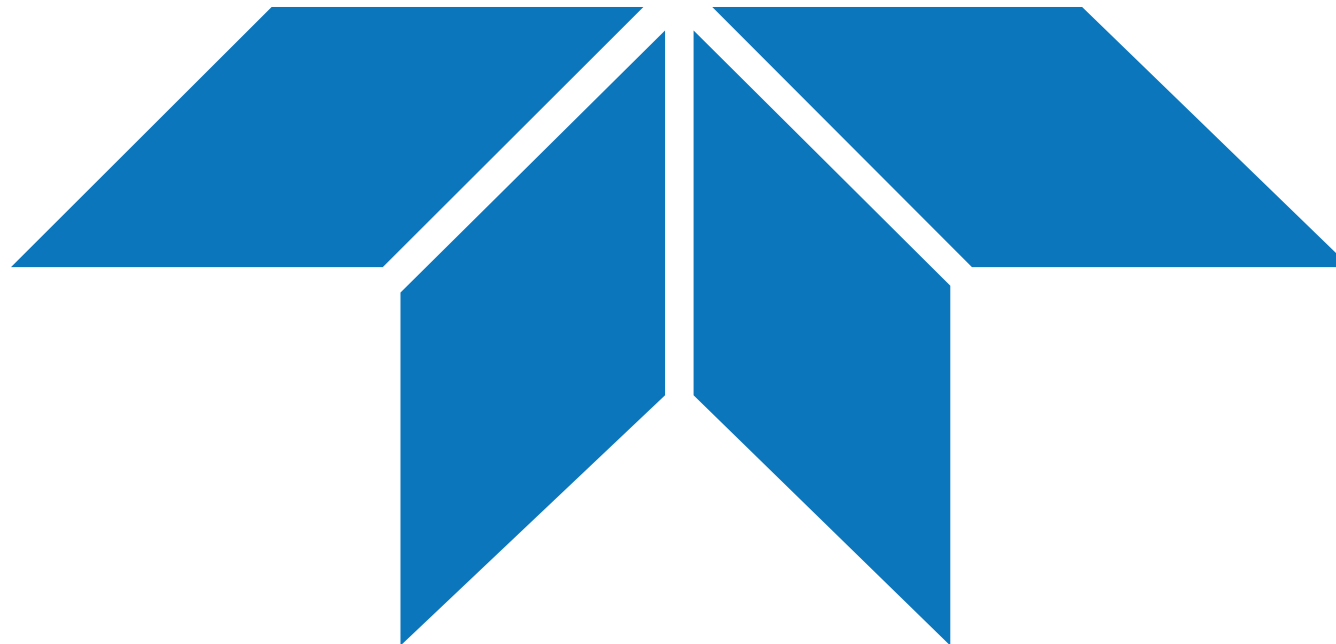
- Teledyne e2v Radiation Tolerant Data Processing Solutions

Zoom on Teledyne e2v Data Processing Solutions for Space

- LX2160-Space, latest 16-Core ARM Cortex A72
- Space Qualification Strategy

Focus on LX2160-Space SEL/SEU/SEFI Characterization

- Deep dive in Characterization Strategy



Introduction

Teledyne e2v – Data Processing Solutions
March 2025

Teledyne e2v Semiconductors

Teledyne e2v offers **high-performance, high-reliability** semiconductor solutions, which help solve the most demanding problems of complete signal chain.

With a range of **electronics and packaging solutions**, we cater to applications in the **space, military, civil avionics, industrial, medical and scientific** markets.

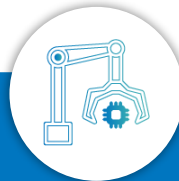
When you want the best ICs to give you winning systems Teledyne e2v Semiconductors has the solutions.



High performance Semiconductors



System in Package & Firmware



Operation & Manufacturing Services



Founded in 1955



A 100% Teledyne subsidiary since 2017



*400 employees
200 engineers*



Grenoble is ranked 5th most inventive city in the world according to Forbes magazine!



Teledyne e2v Data Processing Solutions

Advanced Compute Intensive solutions fully characterized, tested & qualified for Aerospace, Military & Defense environments

- High Reliability Qualification of NXP Data Networking solutions for High Reliability
 - Extended Temperature Range -55/125C, Leaded balls
- High Reliability Qualification thanks to our 40 years partnership with NXP
 - Access to same platforms (test vectors, burn in platforms), same testers as NXP
 - Leading to highest quality testing and same test coverage
- Full Radiation characterization (TID, SEE Heavy Ions, Protons & mitigations) for Space



LS1046 (Mil) &
LS1046-Space
4-Core ARM® Cortex A72



LX2160 (Mil) &
LX2160-Space
16-Core ARM® Cortex A72



4 / 8 / 16 GB DDR4
Ultra Compact Space
DDR4 Memories



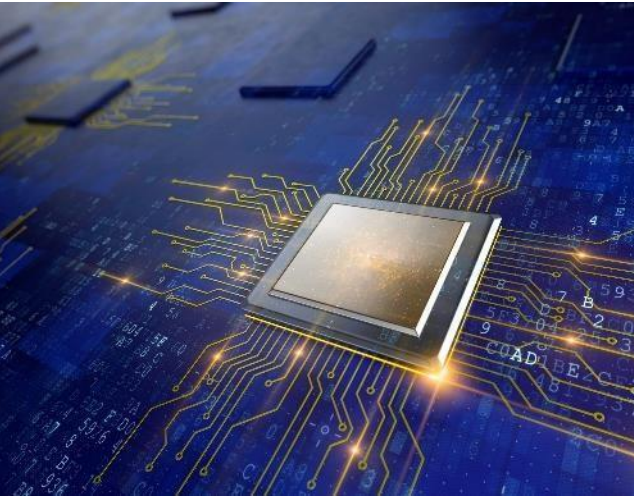
QLS1046-Space
4-Core ARM® Cortex A72 + DDR4



QLX2160-Space
16-Core ARM® Cortex A72
+2 x 8/16GB DDR4

Edge Applications in Space with Teledyne e2v processing solutions

Processors, Memories & Processing Modules



New Space Platforms
& Landers



Sensor & Data Fusion
On Board
(Scientific Missions)

On Board Processing
Autonomous Decision
making
Image Processing
AI enabled in Space



Ground-Space & Sat-2-Sat
Communications &
Data Routing
(Servers in the Sky)



Teledyne e2v Semiconductor Solutions

Addressable Projects & Target Applications in Space

Satellites: Intelligence Gathering, Earth Observation, Communication, ...



Power Management

Positioning

Propulsion

Sub-system Control / Monitoring / Watchdog

Satellite Bus
Routing of data

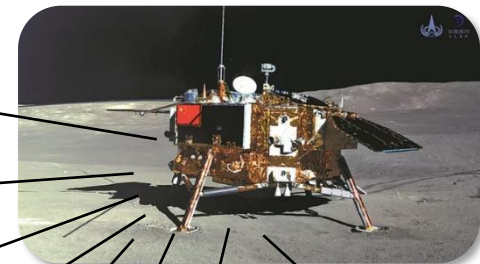
Payload Sensing
(Observation)

Payload Transponders
(Telecom)

Payload GNSS
(Location)

Data Link / TT&C
(To ground & sat-to-sat)

Space Landers, Launch Vehicles



Payload

Space Avionics

Robotics

Power Management

Bus
Routing of data

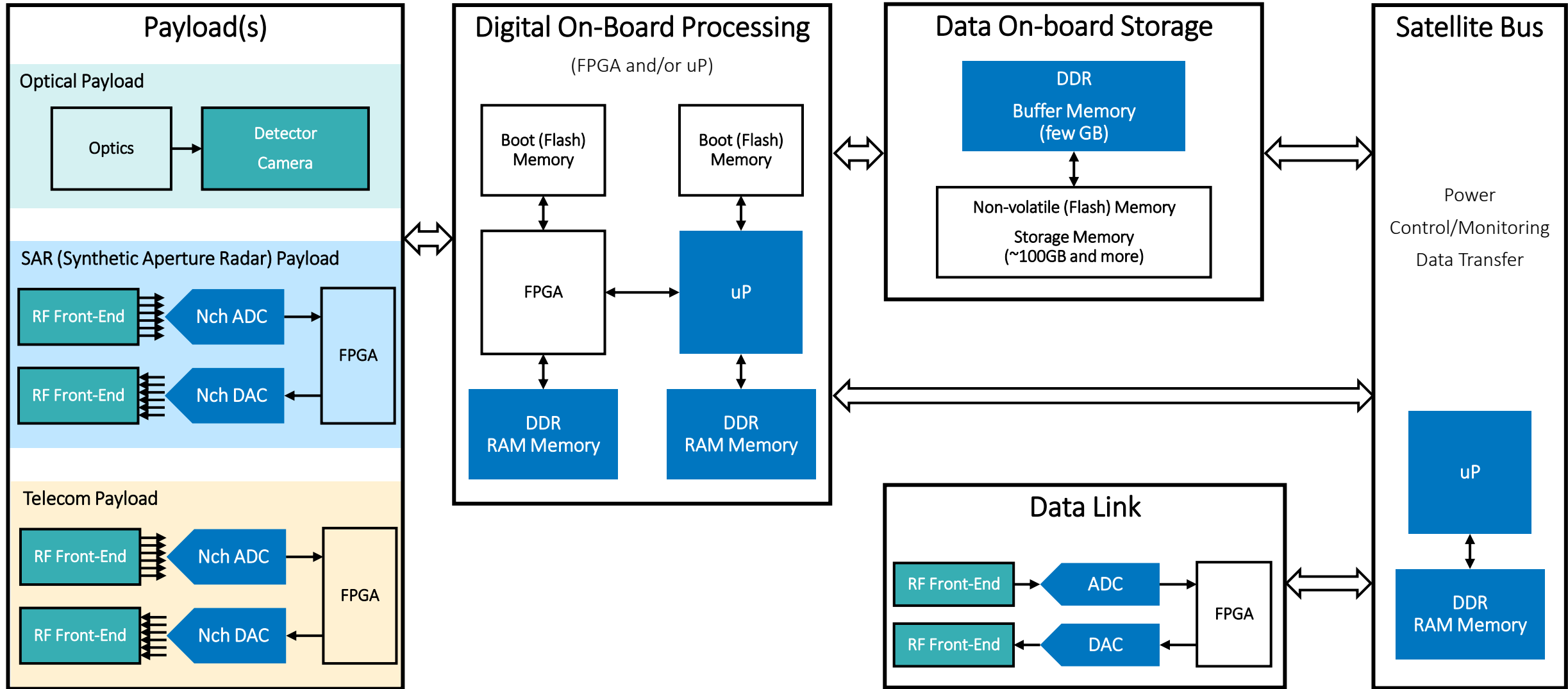
Data Link / TT&C

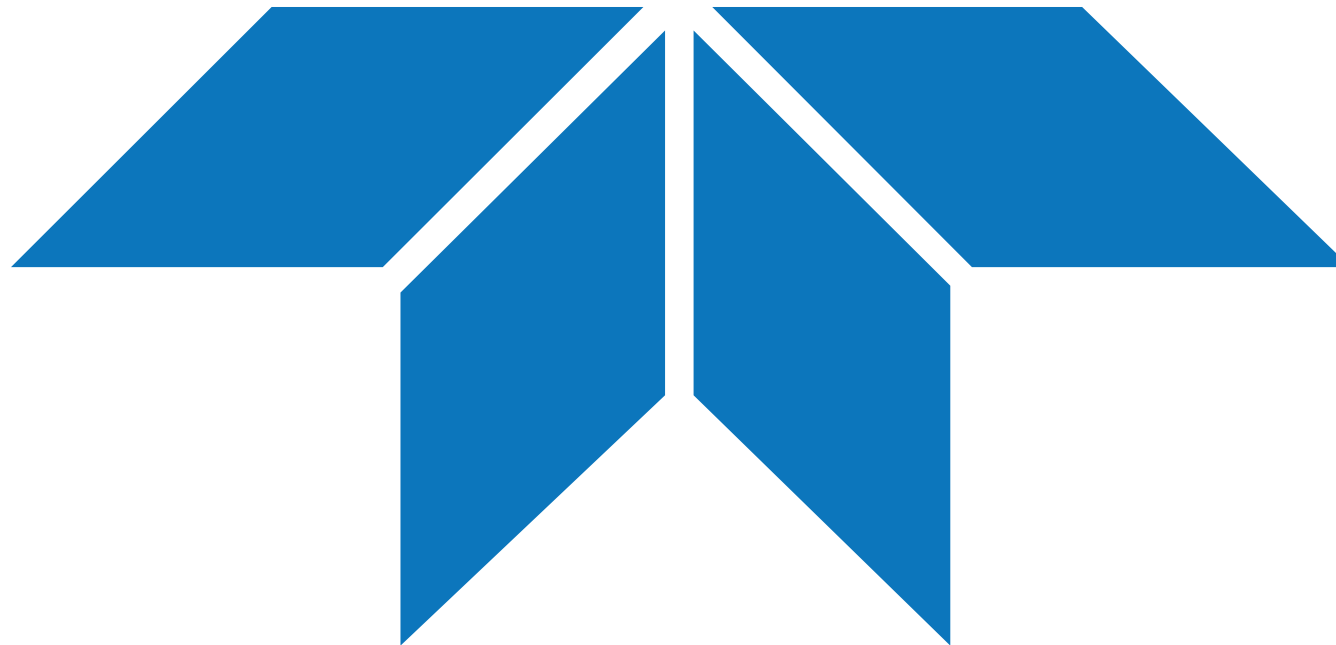
Positioning

Sub-system Control / Monitoring / Watchdog

Addressable with Teledyne e2v Data Processing Solutions

Satellite – High level Architecture



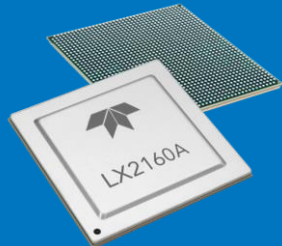


Zoom on Teledyne e2v Data Processing Solutions

Teledyne e2v – Data Processing Solutions
March 2025

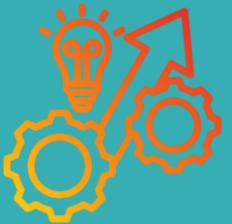
LX2160-Space : 16-Core ARM® Cortex® A72 System On Chip

 [More information here.](#)



200k DMIPS
Rich Set of peripherals

Low Power Multicore
~2W Power consumption /core



2nd Generation ARM® based
Multi core processor for
High-Reliability Applications

Suit all space missions
from LEO to GEO



Proven Track Records and
Space Heritage



Highest performance for
Military & Defense systems



LX2160

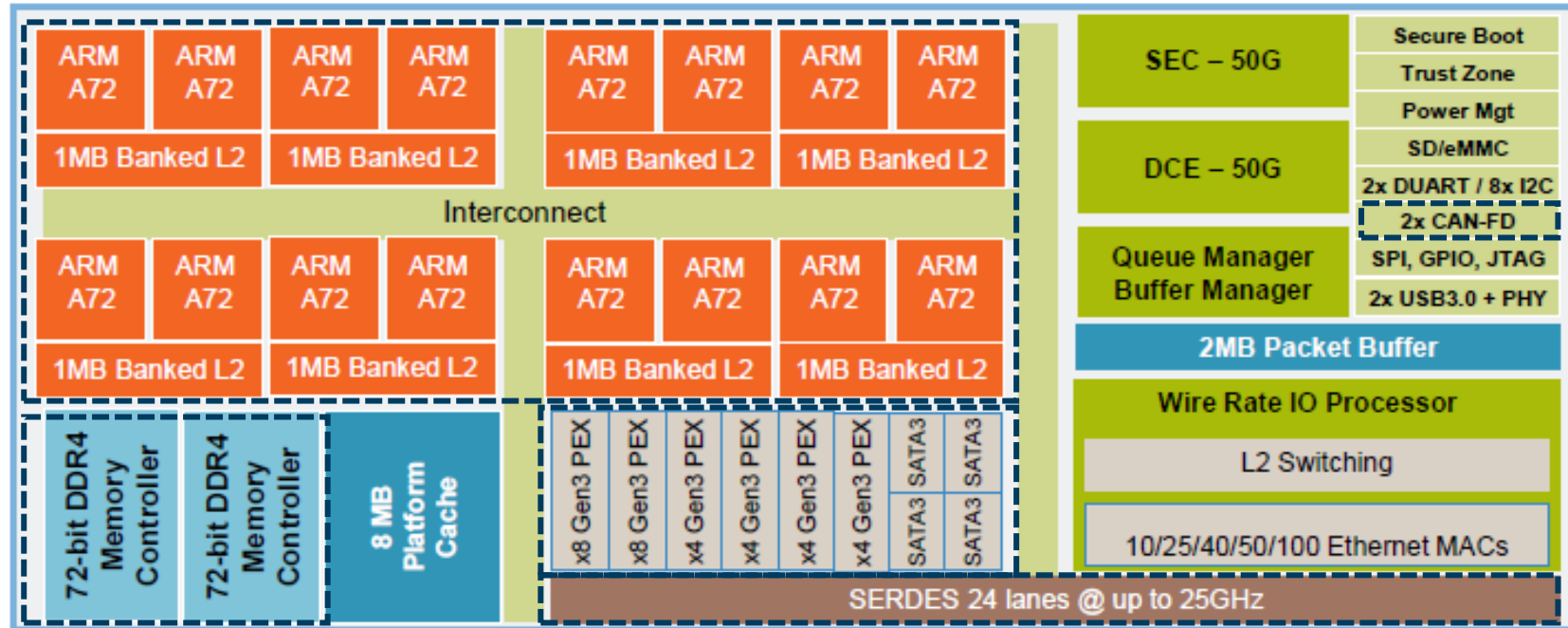
High Level View

Performance

- ARM A72 x 16 @ 2.2 GHz
- ~201K DMIPS
- SpecInt2k6 -17.6, Rate -157
- Neon SIMD in all CPUs
- 2x72b (including ECC) DDR4 up to 3.2GT/s
- 51GB/s memory BW
- High Speed IO
- Multiple PCIe Gen3 controllers
- Multiple Ethernet MACs (up to 100G)

Functional Safety

- Target QM(B)
- ECC protected memories
- Fault localization, containment and recovery
- Soft lockstep with determinism
- Excellent support for virtualization, containerization



Security

- 50Gbps Crypto Acceleration
- MACSEC, IPsec, SSL
- Trust Architecture
- Secure Boot & Debug
- Secure Storage
- Tamper Detection
- HW Enforced Partitioning
- ARM Trust Zone

Space Specific

- NASA & ECSS Space Qualification
- -55/125C Temperature Range
- Radiation Testing & Reports

Process & Package

- 16FFC
- ~25W Thermal Max @ 105C -2.0GHz
- 40x40mm, Lidded FCBGA, 1mm pitch (1517 pins)

LX2160 – Timeline and Documentation

 Click on links to download documents

LX2160 Timeline

Military Grade → Production

Space Grade :

- EMs → Available
- FMs → Orderable Now

Implementing the product

- [LX2160 Product Page](#)
 - LX2160 Datasheet
- [LX2160-Space Product Page](#)
 - LX2160-Space Datasheet

Radiation Reports

- LX2160 - SEL derisking report
- TID Radiation report
- SEL Radiation Report
- SEE Initial Radiation report
(Incl. SEU/SEFIs Core/Cache)
- SEE Radiation report
(incl. SEU/SEFIs of all peripherals)
- Proton Radiation report



LX2160 Video

Discover our advanced 16-core 64-bit Arm processor

Teledyne e2v NASA Space manufacturing flow

Teledyne e2v Space Qualification Flow

Space Level Screening

- **Serialization**
 - ✓ *Clearly identify every device manufactured*
- **Ruggedized to Hi-Reliability**
 - ✓ *-55C to +125C*
 - ✓ *Non-RoHS*
- **100% inspection**
 - ✓ *X-rays, CSAM, visual, dimensional ensuring defect-free flight units*
- **Advanced dynamic & static burn-in**
 - ✓ *To eliminate infant failures*

Lot by lot Qualification

- **Life test, Temp. cycling, HAST testing**
 - ✓ *On every lot manufactured*
 - ✓ *Guarantee compliance with Space Grade*
- **DPA performed on every lot**

ECSS / EEE-INST-002 Levels

Level 1

- *Commercial communication satellites*
- *Weather monitoring and Earth observation satellites*
- *Launch Vehicles*
- *Manned Space Flight*

Level 2

- *Cubesats and Satellite Constellations*
- *Science missions*

Level 3

- *Cubesats*
- *Short space missions*

Reliability ↑

High end Space Qualification

Higher Samples lot
Increased Life Cycle Tests
Increased Test Hours






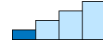
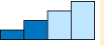
Entry level

Lower Samples Lot
Reduced Life Cycle Tests

Versatility of Space Quality Level

Enabling optimized qualification level vs. cost for each mission with a single platform

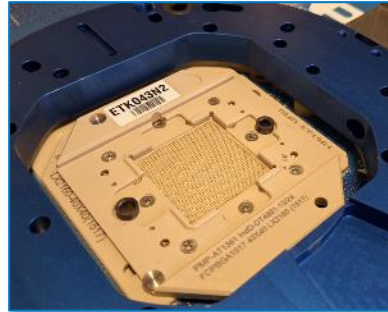
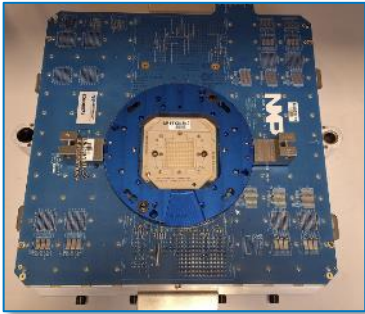
Memory and Processor quality flow

		Nasa 1 (N1)	Nasa 2 (N2)	Nasa 3 (N3)	ECSS 3 (E3)	New Space (X1)
<u>Space Screening</u>	Temperature cycling	Yes	Yes	Yes	No	Yes
	Burn-in	Yes 	Yes 	Yes 	No	No
	CSAM or X-Ray (Non destructive analysis)	100%	100%	100%	No	Sampling
	Serialization	Yes	Yes	Yes	Yes	No
<u>Lot Qualification</u>	Single Lot Date Code	Yes	Yes	Yes	Yes	Yes
	Quality Conformance Inspection or Lot Acceptance (Life & Stress Tests)	Yes 	Yes 	Yes 	Yes 	No
	DPA (Destructive Physical Analysis)	Yes	Yes	Yes	Yes	No
<u>Radiation Performance</u>	Tested and Characterized for Space					
	TID	100K rad (SI)	100K rad (SI)	100K rad (SI)	100K rad (SI)	35K rad (SI)
	SEE (Data available up to)	> 60MeV.cm2/mg	> 60MeV.cm2/mg	> 60MeV.cm2/mg	> 60MeV.cm2/mg	> 43MeV.cm2/mg
	Temperature range	-40 to +105°C -55 to +125°C	-40 to +105°C -55 to +125°C	-40 to +105°C -55 to +125°C	-40 to +105°C	-40 to +105°C

Teledyne e2v Space Qualification Strategy - Highlights

Testers, Test Programs & Test Interfaces

- Same Testers & Test Interfaces than NXP
- Same Test Programs



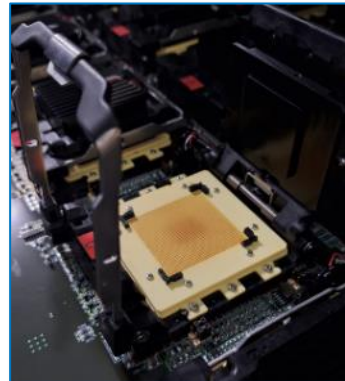
Handler



- Esmo Talos Automatic Handler
- -55 / 125C Temperature Range
- Text Recognition (serial #, IDs, ...)

Burn In

- Same Burn In Boards & Burn In Oven than NXP
- Same Burn In Programs



Teledyne e2v Strategy for Radiations Characterization

“Radiation Tolerant”

- No damage due to radiations
- Can be subject to SEU (upsets) or SEFI (functional interrupts)

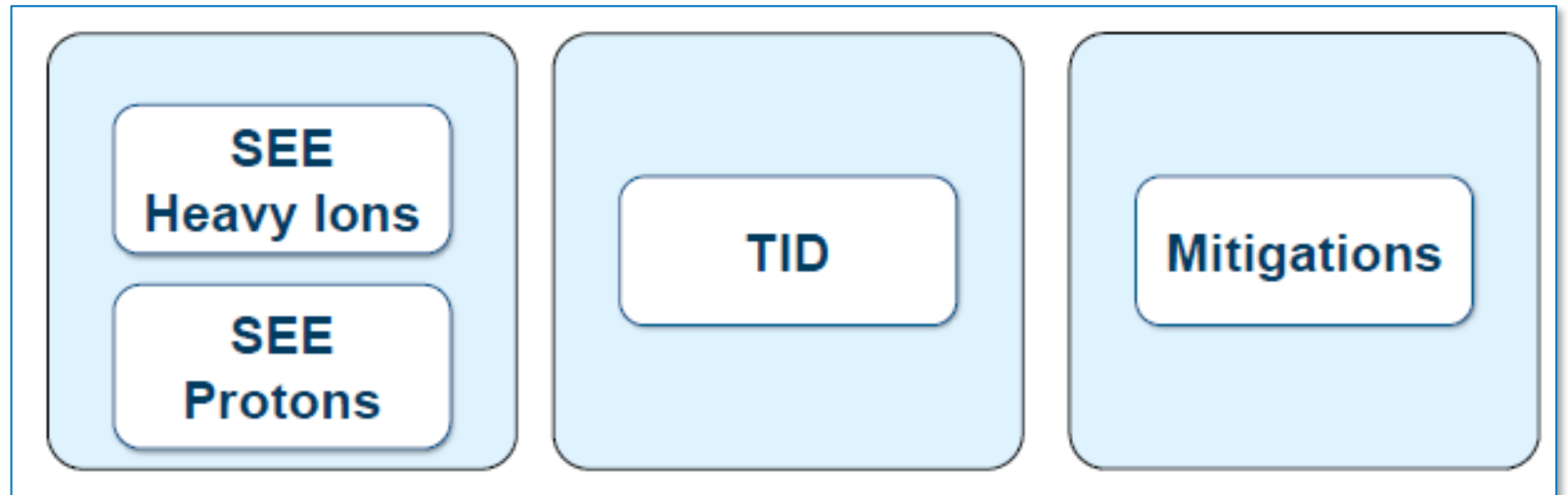
➤ SEE (Single Event Effects)

- SEL immunity verification (Latchup)
- SEU / SEFI characterization

➤ TID testing (Total Ionizing Dose)

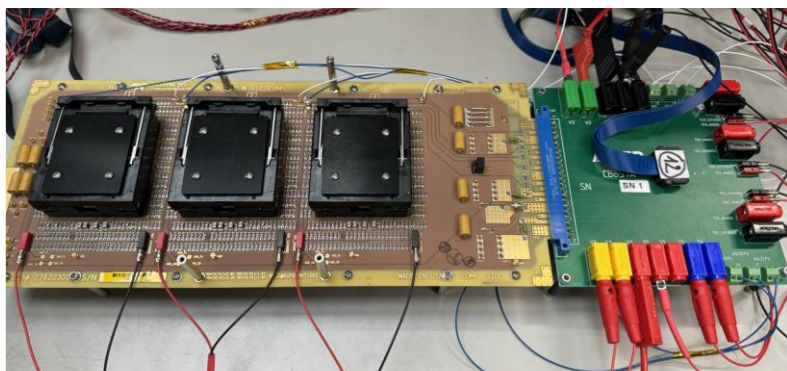
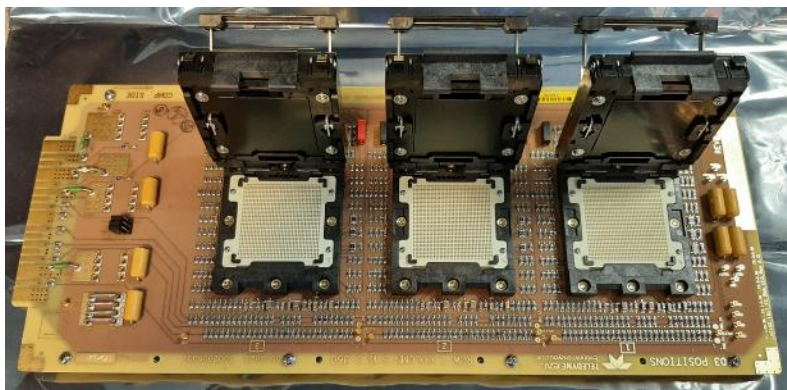
- Verify lifetime in Space
- Lot by lot

➤ Mitigations techniques



Radiation Test Hardware : LX2160-Space example

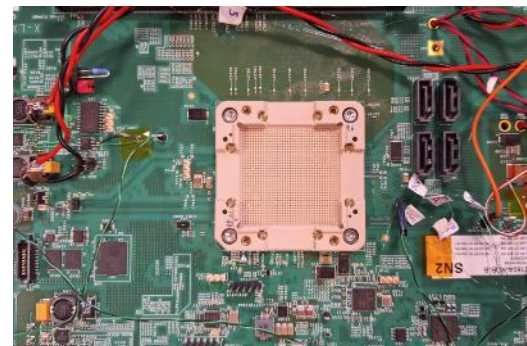
TID



3 parts per socket

Power On Reset pattern send to the devices under tests

SEL



Specifically tuned LX2160A-RDB Board from NXP

Dedicated socket to easily change parts

Teledyne e2v Radiation Reports

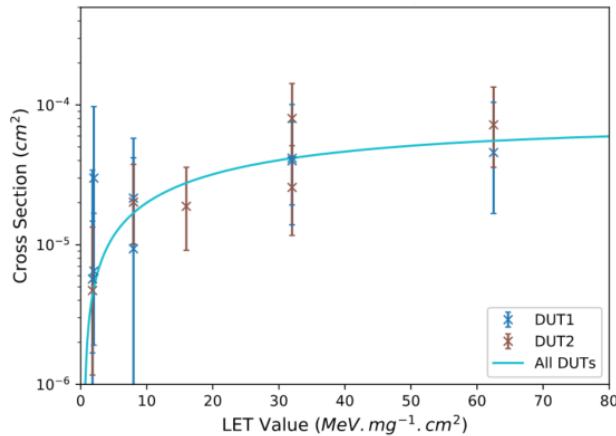
Examples based on LS1046-Space / Quad core ARM® Cortex® A-72

DUT (Part ID)	Ion Specie	Effective LET [MeV.cm ² /mg]	Run Duration [s]	Temperature (Diode) [°C]	Entered Fluence [ions/cm ²]	SEL count
4	126Xe44+	62.5	619	125	1.00E+07	0
4	126Xe44+	62.5	551	125	1.00E+07	0
4	126Xe44+	62.5	515	125	1.00E+07	0
3	126Xe44+	62.5	561	125	1.00E+07	0
2	126Xe44+	62.5	603	125	1.00E+07	0
4	89Kr29+	32	931	125	1.00E+07	0

SEL Results (Extract)

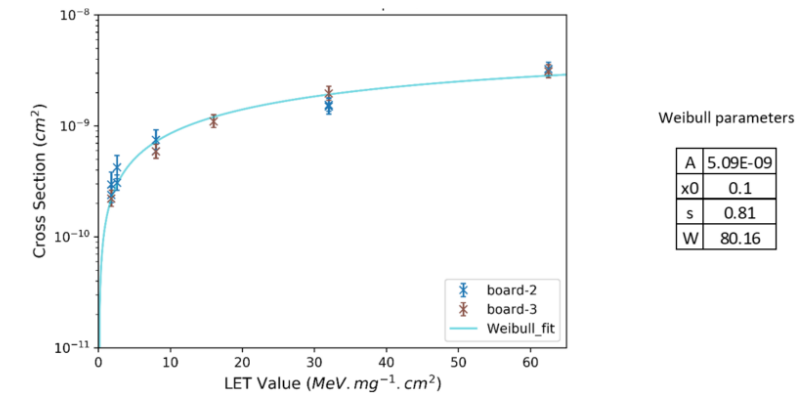
DUT (Part ID)	Ion (Symbol)	Test mode	Effective LET [MeV.cm ² /mg]	Run Duration [s]	Fluence (Effective) [ions/cm ²]	Flux [ions/cm ² .s]	H Reset (single)	H Reset (multiple)	PO Reset	Power Cycle	SEFI (Total)	Cross Section/device [cm ²]
2	Xe	I2+oc	62.5	1084	1.53E+05	185	4	3			7	4.57E-05
3	Xe	I2+oc	62.5	1208	1.94E+05	414	11	3			14	7.23E-05
2	Kr	I2+oc	32	1044	1.44E+05	193	4	2			6	4.16E-05
2	Kr	I2+oc	32	1172	3.26E+05	1024	5	8			13	3.99E-05
3	Kr	I2+oc	32	919	2.12E+05	1306	8	9			17	8.02E-05
3	Kr	compress	32	757	4.28E+05	1585	6	3	2		11	2.57E-05
3	Fe	I2+oc	16	972	6.90E+05	1235	10	2	1		13	1.88E-05
2	Ar	I2+oc	8	633	5.57E+05	1896	12				12	2.15E-05
2	Ar	I2+oc	8	534	1.07E+05	225	1				1	9.36E-06
3	Ar	I2+oc	8	1012	6.93E+05	1186	11	3			14	2.02E-05
2	Ne	I2+oc	2.6	526	7.73E+05	2281	5				5	6.47E-06
2	Ne	I2+oc	2.6	564	1.00E+05	213	3				3	2.99E-05
2	O	I2+oc	1.8	581	8.79E+05	2065	4	1			5	5.69E-06
2	O	I2+oc	1.8	491	1.20E+05	244	0				0	
3	O	I2+oc	1.8	480	8.50E+05	2500	3	1			4	4.70E-06

SEFI Classification (Extract)

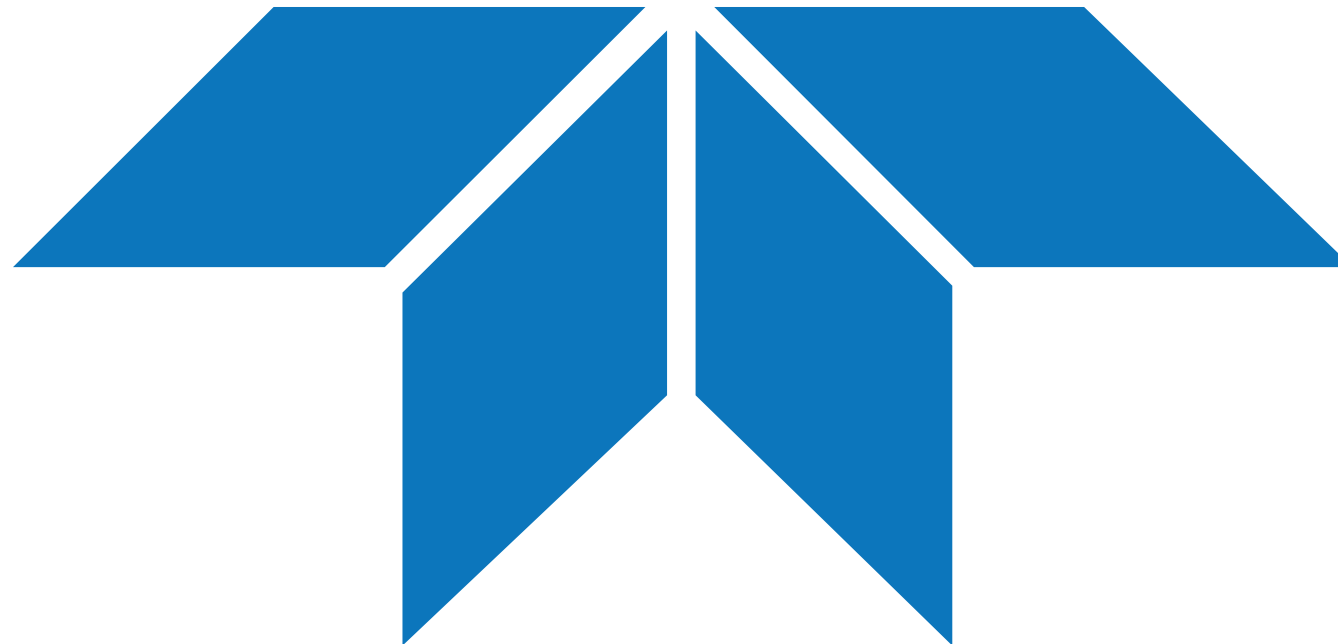


SEFI Cross Section (Extract)

All Teledyne e2v Radiation Reports are available to our customers so they can assess the performances and behavior of the components in their applications in Space



SEU Cross Section (Extract)



LX2160-Space

Focus on SEL/SEU/SEFI Characterization

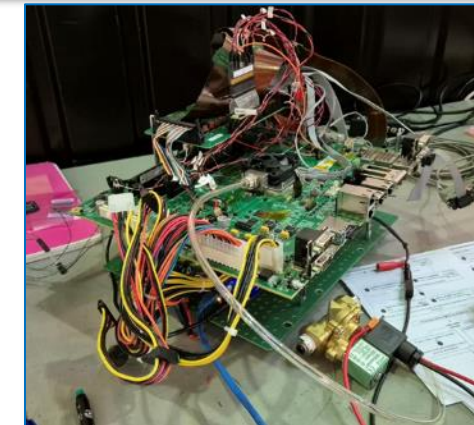
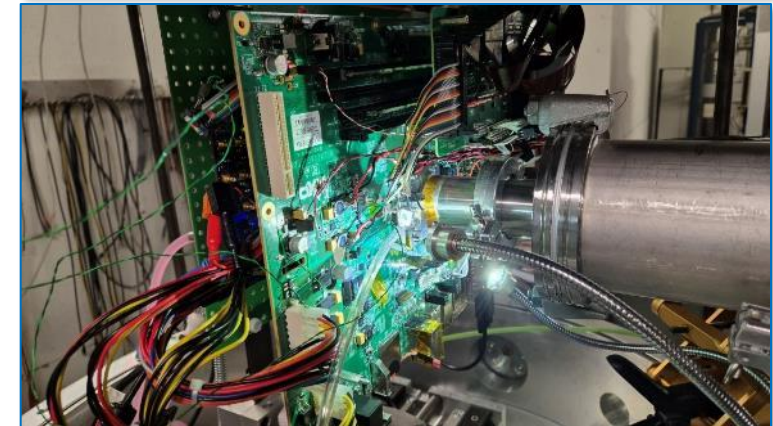
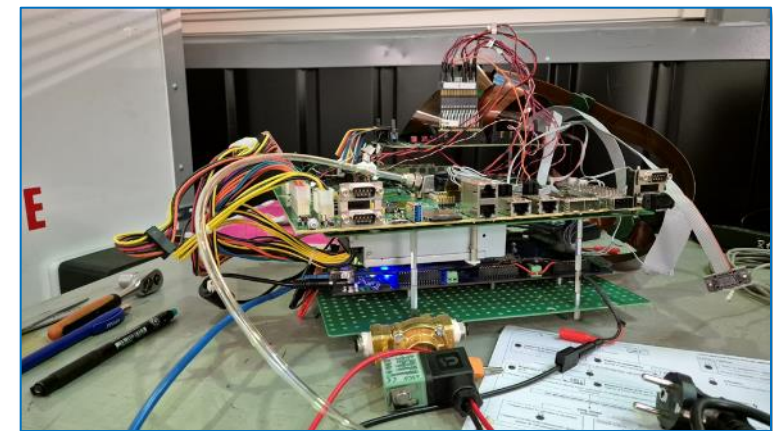
Teledyne e2v – Data Processing Solutions
March 2025

LX2160-Space

SEL / SEU / SEFI Characterization Strategy

- **Customization of LX2160 NXP reference design board**
 - Specific Implementation of supplies control
 - Supplies monitoring
 - Use of socket versus soldered device on the board
- **Continuous & iterative SW development**
- **Implementation of Dry runs for more efficiency during beam tests**
- **Characterization breakdown**

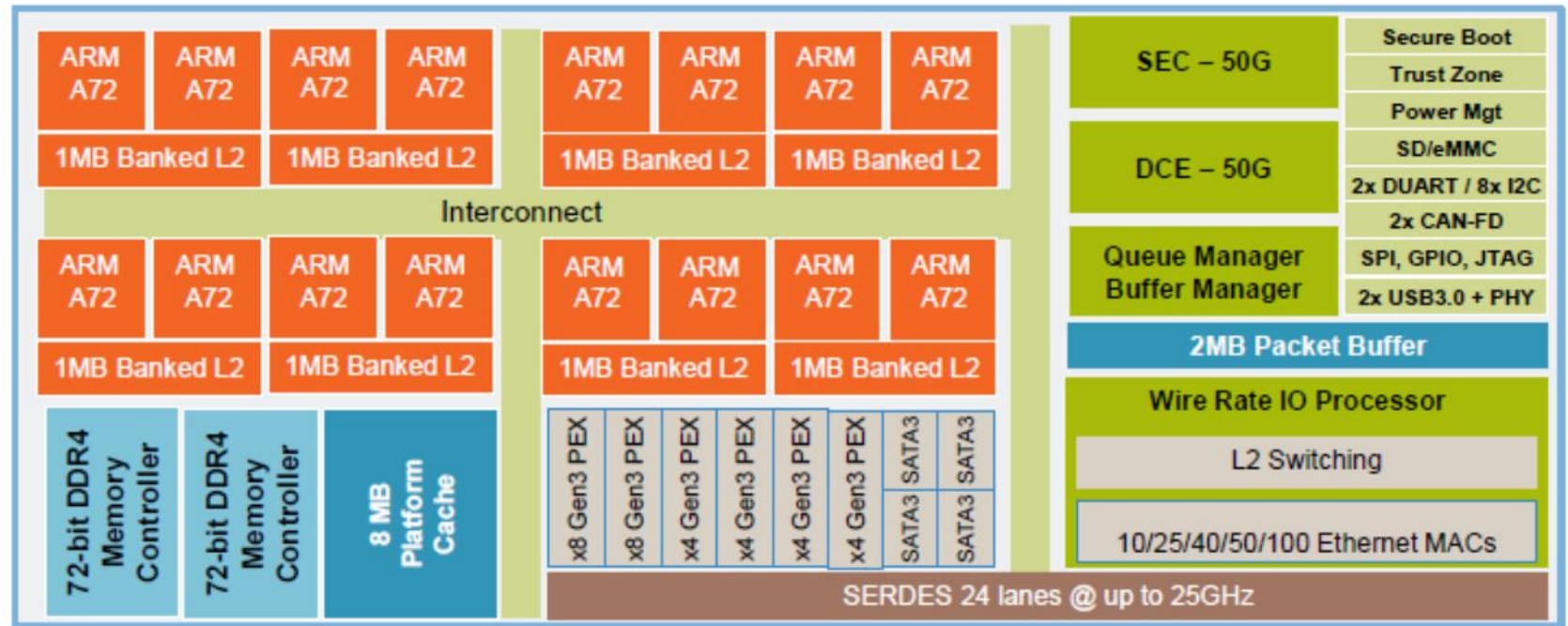
SEL	4x Heavy Ions	~40 hours	
SEE	4x Heavy Ions	~60 hours	<ul style="list-style-type: none"> • Testing of most relevant peripherals (see next slide) • SEFI classification
SEE	1x Heavy ions (optional)	~16 hours	<ul style="list-style-type: none"> • Additional peripherals
Protons	1x session	~16 hours	



LX2160-Space

SEL/SEU/SEFI Characterization Deep Dive

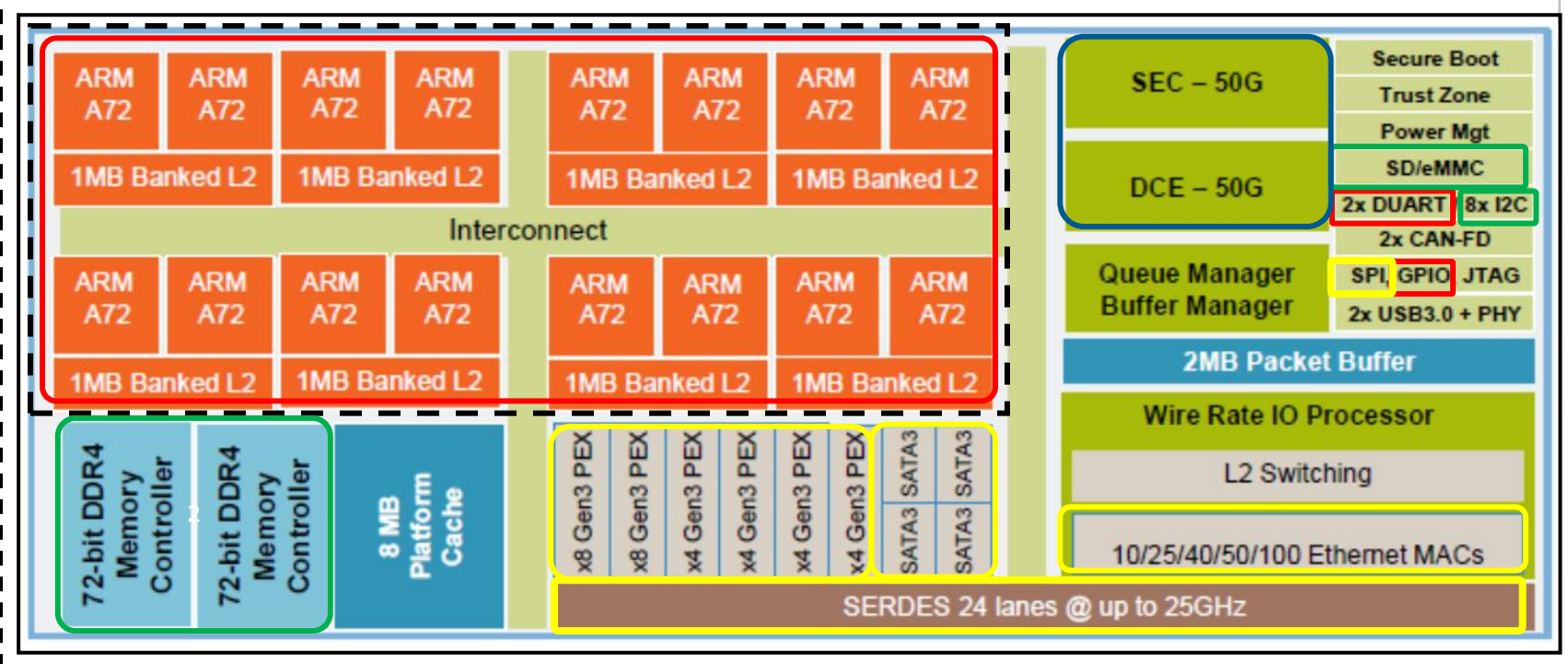
Total 140+ hours Beam time to fully characterize the device



		Nb Hours	ARM Cores	Cache	UART	GPIO	DDR Controller	eMMC / SD	i2C	Flex SPI	SPI	SERDES	Ethernet	SATA	CAN	SEC / DEC	Interrupt Controller	DMA	Others (USB, ...)
Campaign 1	LU Derisking	2x10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Campaign 2	SEL	2x10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Campaign 3	SEL Core & L2\$	10	X	X															
Campaign 4	SEU / SEFI	10	X	X	X	X													
Campaign 5	SEFI	10			X		X	X	X	X									
Campaign 6	SEFI	16									X	X	X	X	X				
Campaign 7	SEFI	16														X	X	X	
Campaign 8	SEFI	16	Optional beam time for additional peripherals and/or Characterization fine tuning																
Campaign 9	Protons	16	Optional beam time for additional peripherals characterizations																

LX2160-Space

SEL/SEU/SEFI Characterization Deep Dive



		Nb Hours	ARM Cores	Cache	UART	GPIO	DDR Controller	eMMC / SD	i2C	Flex SPI	SPI	SERDES	Ethernet	SATA	CAN	SEC / DEC	Interrupt Controller	DMA	Others (USB, ...)
Campaign 1	LU Derisking	2x10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Campaign 2	SEL	2x10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Campaign 3	SEL Core & L2\$	10	X	X															
Campaign 4	SEU / SEFI	10	X	X	X	X													
Campaign 5	SEFI	10			X		X	X	X	X									
Campaign 6	SEFI	16									X	X	X	X	X				
Campaign 7	SEFI	16														X	X	X	
Campaign 8	SEFI	16	Optional beam time for additional peripherals and/or Characterization fine tuning																
Campaign 9	Protons	16	Optional beam time for additional peripherals characterizations																

Conclusion

Teledyne e2v supplies Advanced Rad Tol Space Compute Intensive solutions

- Multi-Core Processors
- DDR4 Memories
- Space computing Modules

Versatility of Space Flows

- Serving New Space applications / LEO
- Up to NASA 1 for GEO and long durations

LX2160-Space / 16x Core ARM® Cortex® A-72 characterized for Space

- Full characterization against radiations with comprehensive reports
- Ready for deployment in all kind of Space Platforms
- Please inquire for more information and for Flight Models ordering



Contact Information

Thomas GUILLEMAIN

Marketing & Business Development
Data Processing Solutions

Thomas.GUILLEMAIN@Teledyne.com

Grenoble - France



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Teledyne e2v System-in-Package Technology for space products

Thursday 27 March, 15.30-15.50

Plenary Room (Giralda)

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